

Past involvement, future requirements, and our potential contributions to the consortium

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POSTGRADUATE
SCHOOL

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NPS has been part of the CICE community for some years

2003: Maslowski, W., and W. H. Lipscomb (2003), High resolution simulations of Arctic sea ice, *Polar Res.*, 22(1), 67–74.

2007: Lipscomb, W. H., E. C. Hunke, W. Maslowski, and J. Jakacki (2007), Ridging, strength, and stability in high-resolution sea ice models, *J. Geophys. Res.*, 112(C03S91), doi:10.1029/2005jc003355.

2008: Maslowski, W., R. Roman, and J. C. Kinney (2008), Effects of mesoscale eddies on the flow of the Alaskan Stream, *J. Geophys. Res.*, 113(C7), doi:Artn C07036 Doi 10.1029/2007jc004341.

2011: McGeehan, T., and W. Maslowski (2011), Impact of Shelf–Basin Freshwater Transport on Deep Convection in the Western Labrador Sea, *J. Phys. Oceanogr.*, 41(11), 2187–2210, doi:10.1175/jpo-d-11-01.1.

2012: Kinney, J. C., and W. Maslowski (2012), On the oceanic communication between the Western Subarctic Gyre and the deep Bering Sea, *Deep. Res. Part I-Oceanographic Res. Pap.*, 66, 11–25.

2015: Roberts, A. F., A. Craig, W. Maslowski, R. Osinski, A. Duvivier, M. Hughes, B. Nijssen, J. Cassano, and M. Brunke (2015), Simulating transient ice – ocean Ekman transport in the Regional Arctic System Model and Community Earth System Model, *Ann. Glaciol.*, 56(69), 211–228, doi:10.3189/2015AoG69A760.

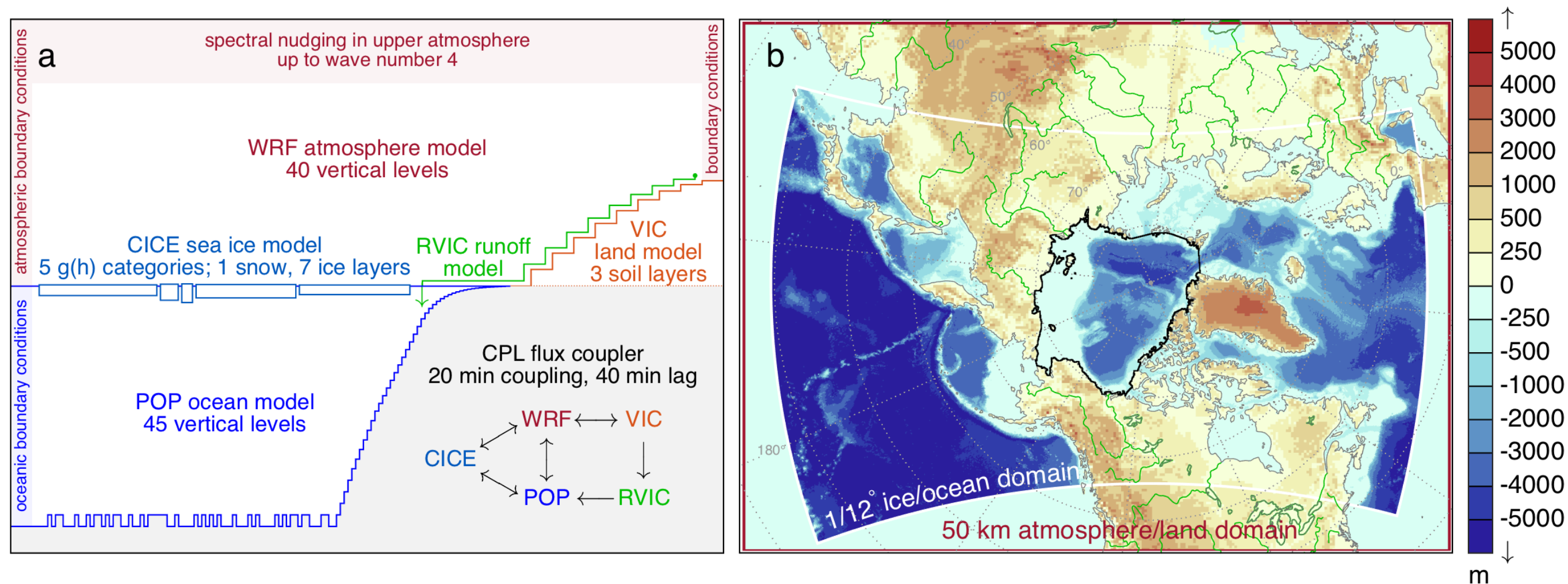
2016: DuVivier, A. K., J. J. Cassano, A. Craig, J. Hamman, W. Maslowski, B. Nijssen, R. Osinski, and A. Roberts (2016), Winter Atmospheric Buoyancy Forcing and Oceanic Response during Strong Wind Events around Southeastern Greenland in the Regional Arctic System Model (RASAM) for 1990–2010*, *J. Clim.*, 29(3), 975–994, doi:10.1175/JCLI-D-15-0592.1.

2016: Hamman, J. et al. (2016), Land Surface Climate in the Regional Arctic System Model, *J. Clim.*, 29(18), 6543–6562, doi:10.1175/JCLI-D-15-0415.1.

⋮

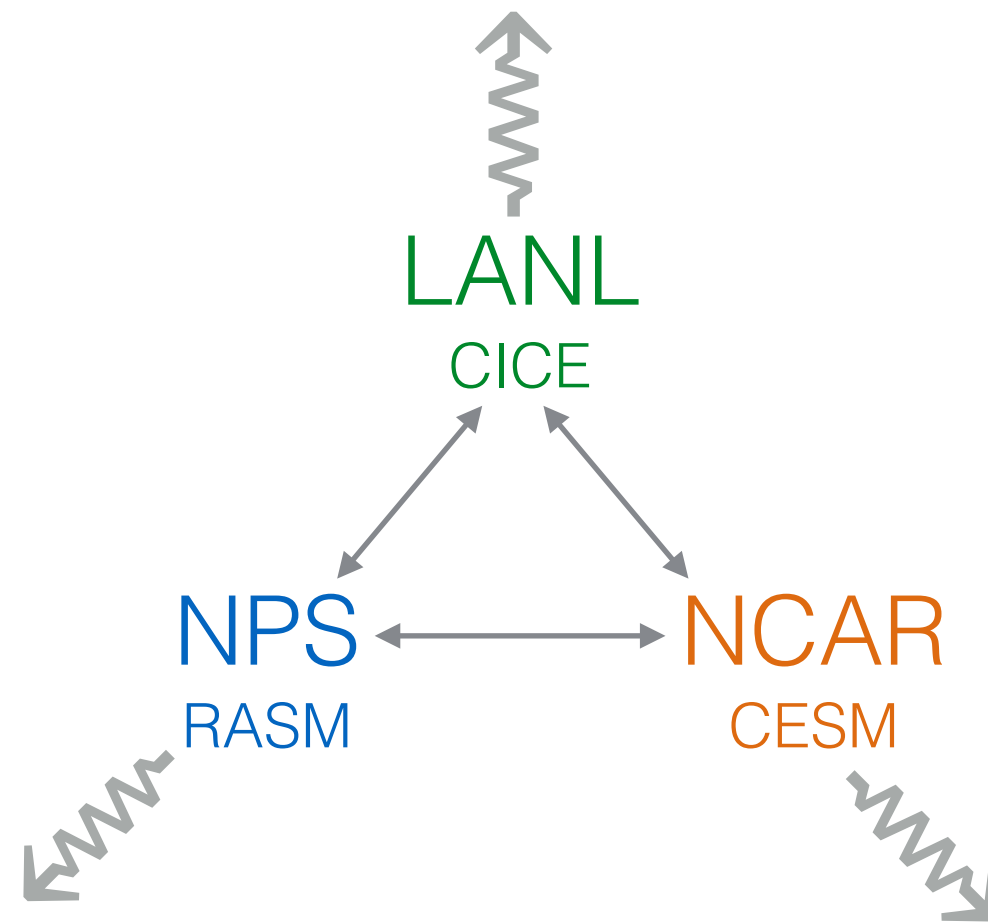
Who are we and what do we do?

The Regional Arctic System Model (RASAM)



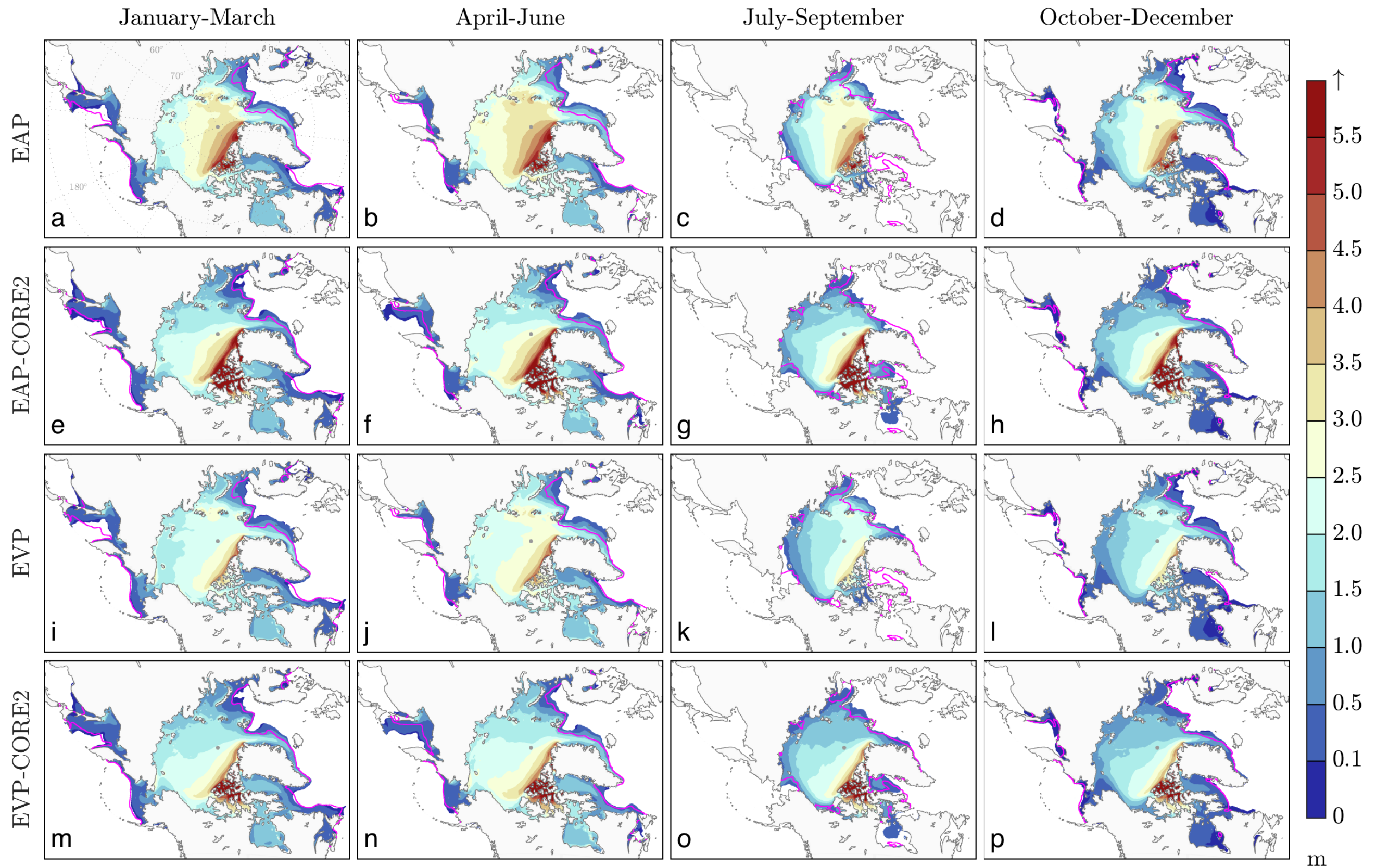
- Created by roughly 30 people from 7 institutions
- Funded by ONR, DOE and NSF
- NPS maintains the sea ice model in RASAM

Joint implementation of CICE 5 in RASM/CESM



RASM uses the CESM infrastructure

Our particular interest is in high resolution simulations



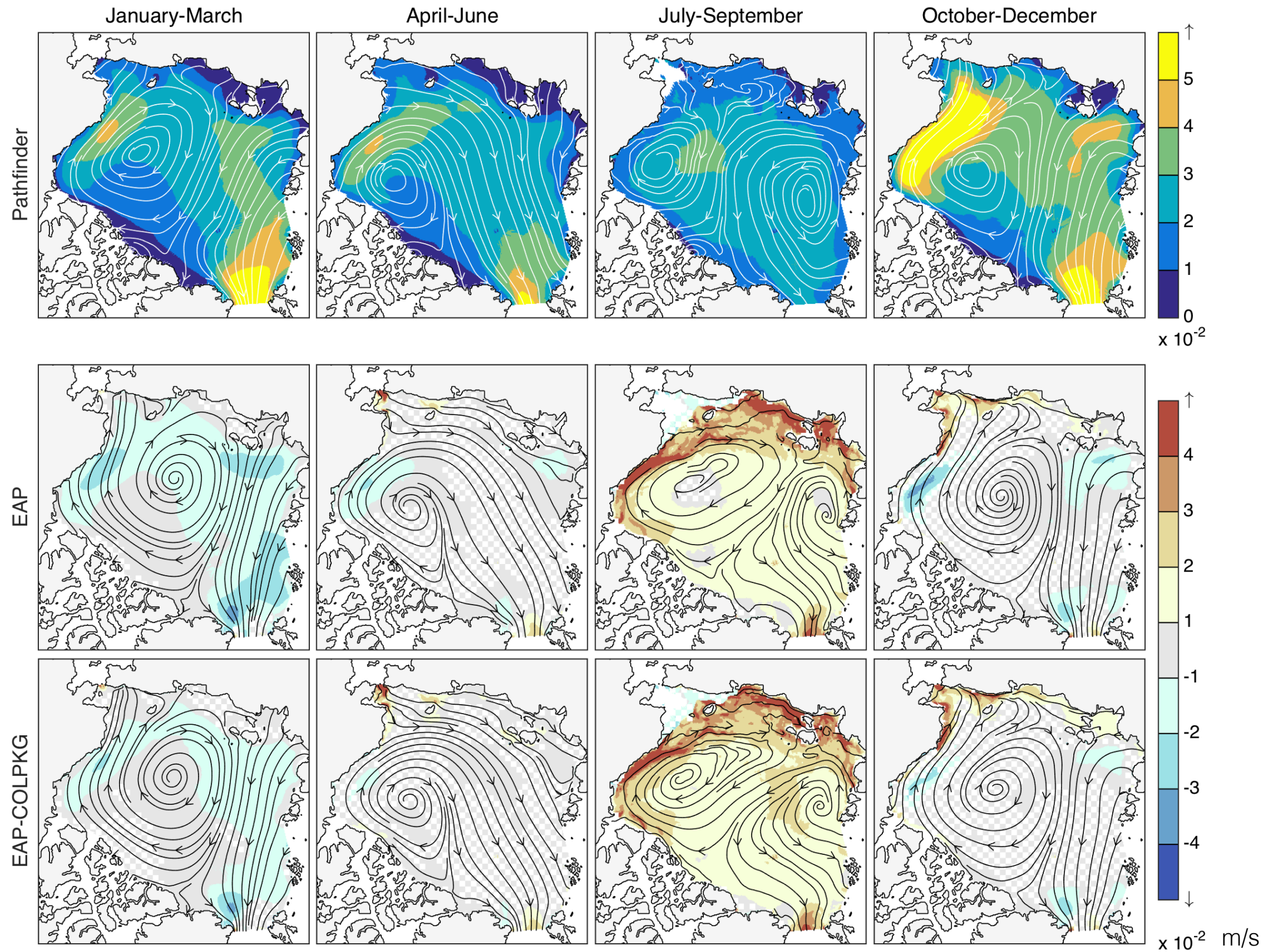
We tightly synchronize our CICE repository with LANL's

* Changes or additions to CICE 5 following RASM's implementation

Melt Ponds	CESM melt ponds (Holland et al. 2012)	
	Level-ice melt ponds (Hunke et al. 2013) *	✓
	Topographic melt ponds (Flocco et al. 2010) *	
Vertical Thermodynamics 7 ice layers, 1 snow layer	Bitz-Lipscomb (prescribed salinity, Bitz and Lipscomb 1999)	
	Mushy Layer (prognostic salinity, Turner et al, 2013) *	✓
Ice Mechanics	Elastic-Viscous-Plastic (EVP, Hunke and Dukowicz, 1997 etc.)	*
	Revised-EVP (Bouillon et al. 2013)	
	Elastic Anisotropic Plastic (EAP, Tsamados et al 2014)	✓
Coupling	RASM Inertial resolving coupling (Roberts et al. 2015) *	✓
	Form Drag *	

We have switched from classic CICE to Dycore+ColPkg

RASM comparison with Pathfinder motion 1990-2009



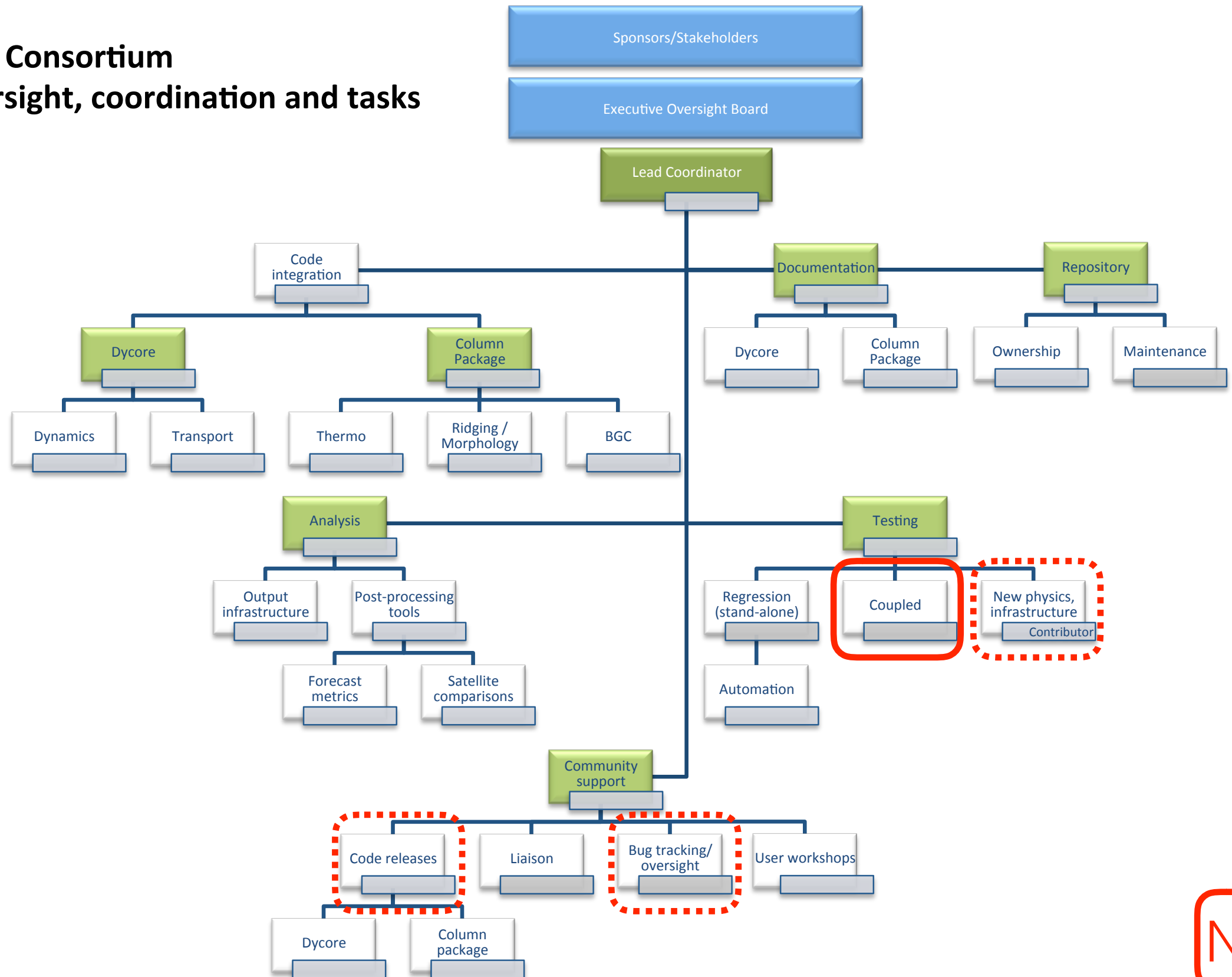
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A well maintained community code composed of
a column physics package and **a dynamical core**
for development of new methods to investigate floating ice
physics and associated biogeochemistry in coupled systems.

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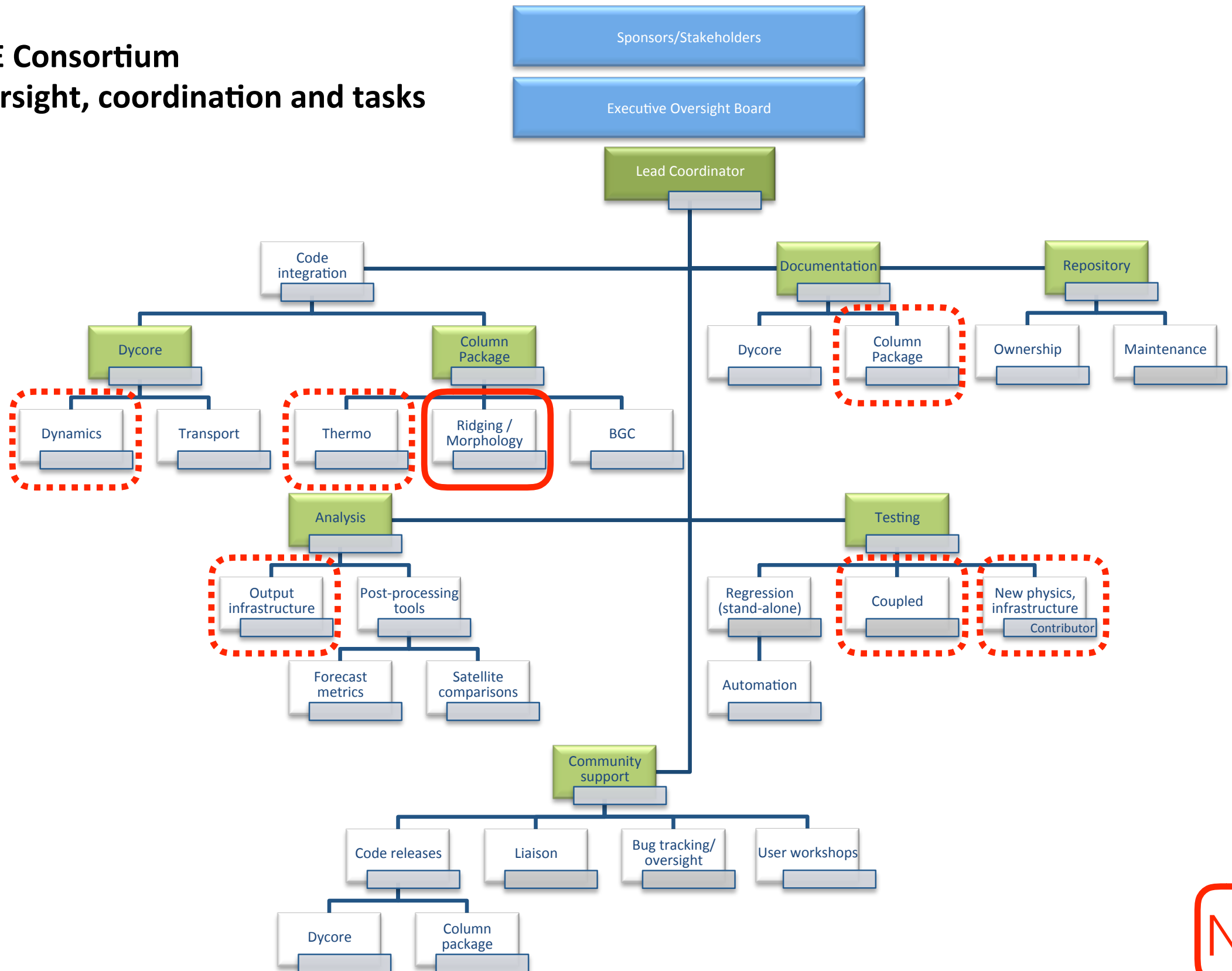
Contribution 1: Routine Maintenance

CICE Consortium Oversight, coordination and tasks

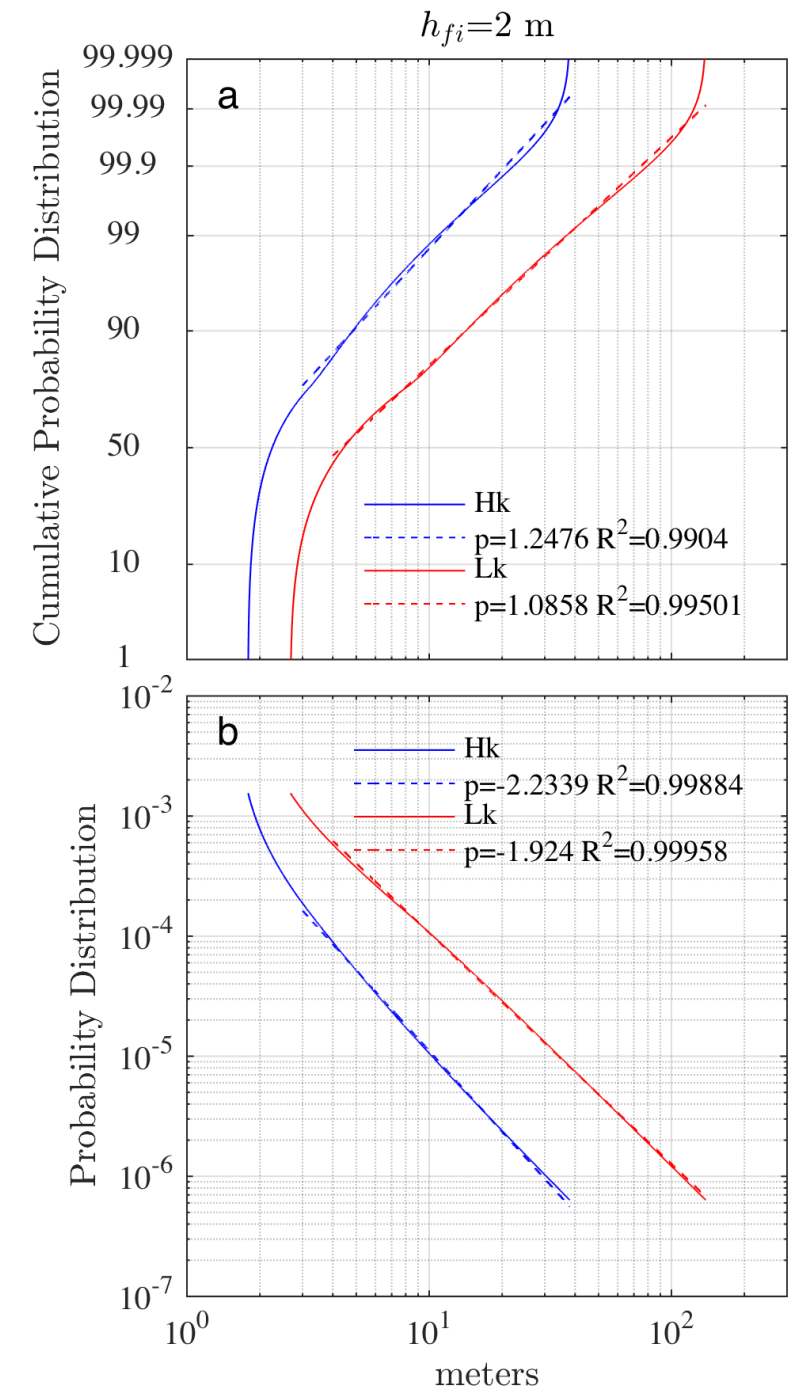
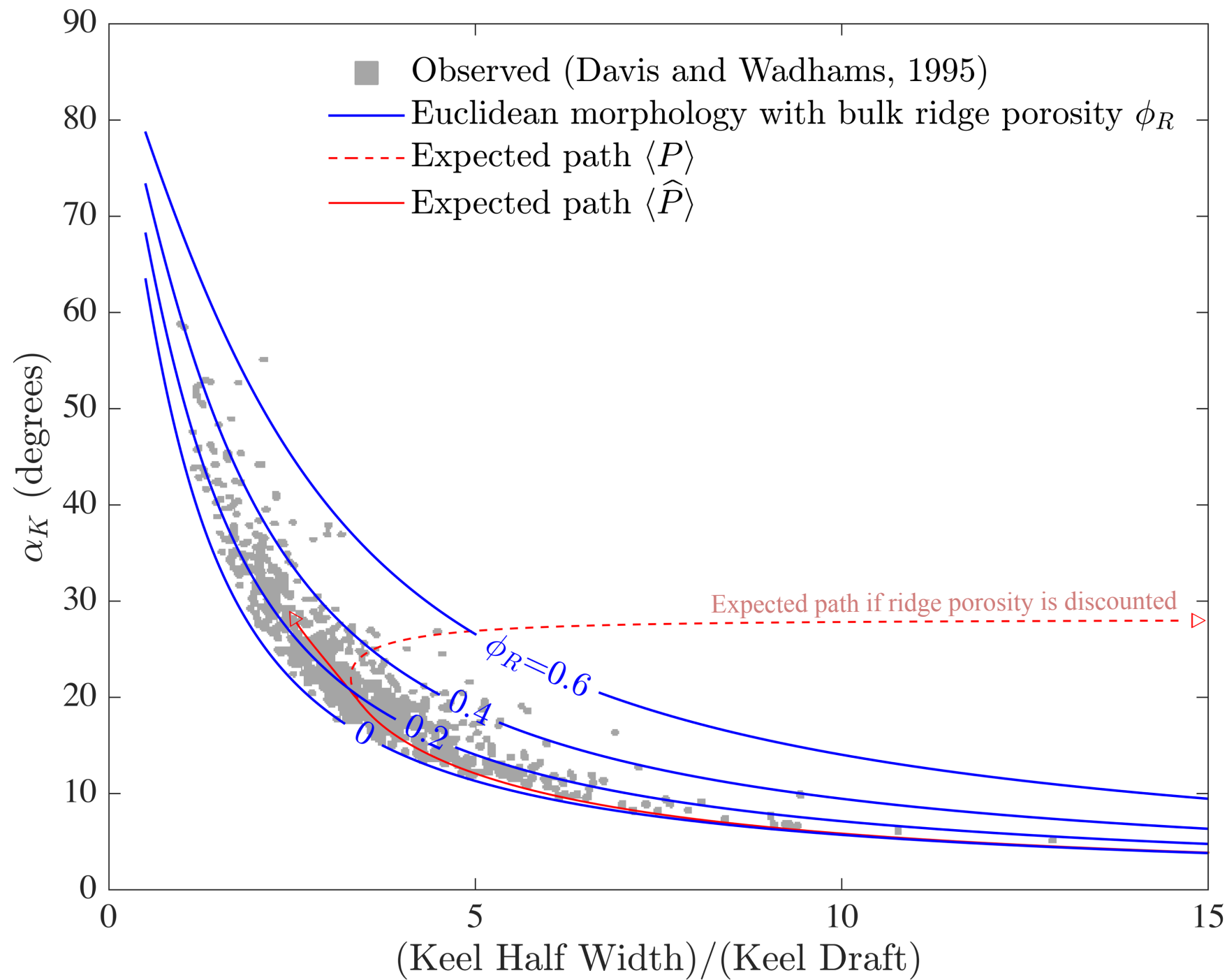


Contribution 2: Variational Ridging $g(h_d, \phi, T)$

CICE Consortium Oversight, coordination and tasks



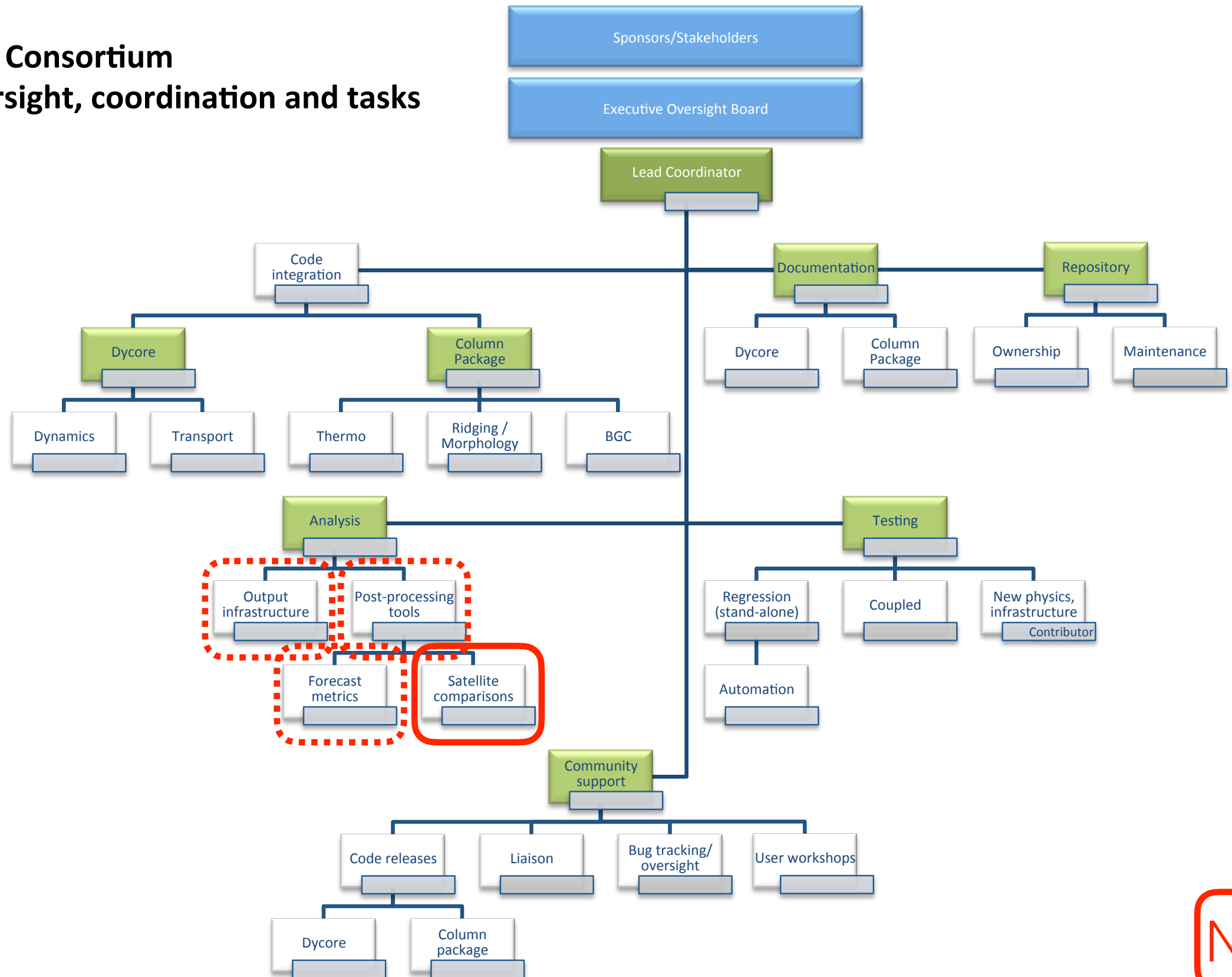
Contribution 2: Variational Ridging $\mathbf{g}(h_d, \phi, T)$



$$\mathcal{A}(\mathbf{g}_{1,2}, h_d(x_{1,2}), \dot{x}_{1,2}) = \mathcal{L}(\mathbf{g}_1, h_d(x_1), \dot{x}_1) - \mathcal{L}(\mathbf{g}_2, h_d(x_2), \dot{x}_2) + \mathcal{F}(\mathbf{g}_{1,2}, h_d(x_{1,2}), \dot{x}_{1,2})$$

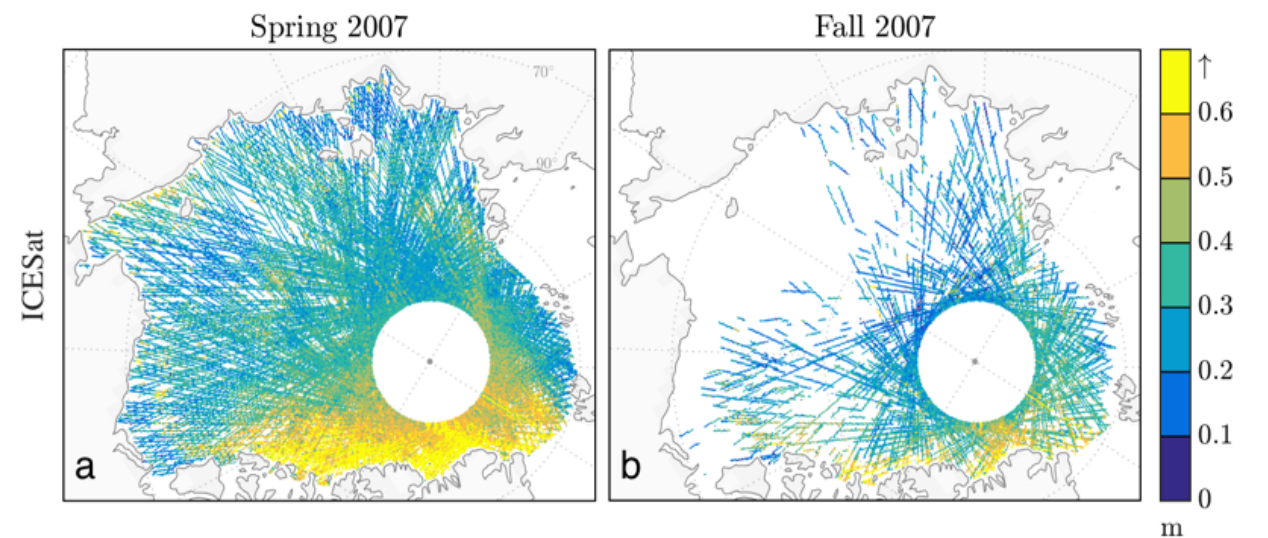
Contribution 3: ICESat/IceBridge/ICESat-2 Emulator

CICE Consortium Oversight, coordination and tasks

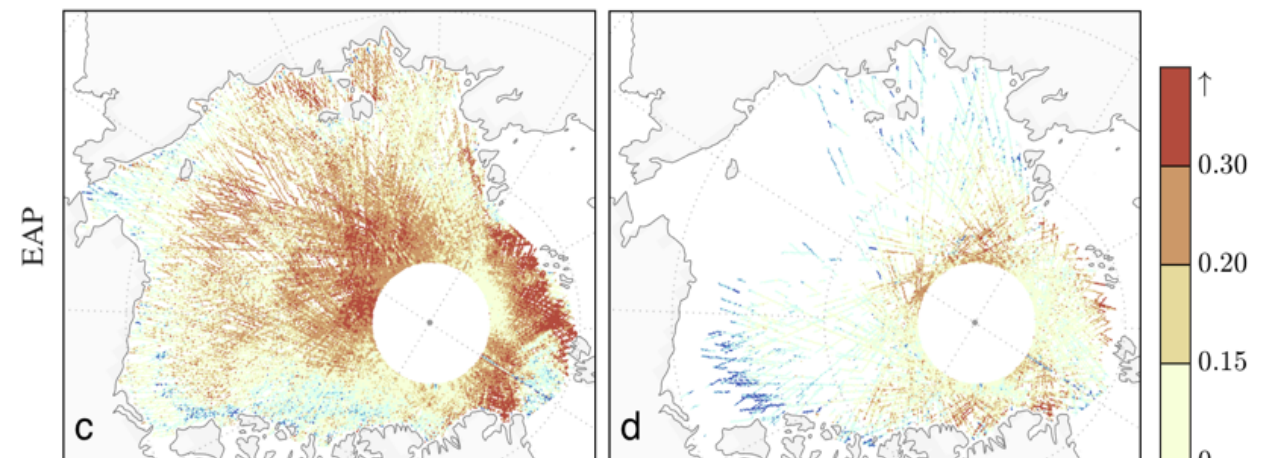


Contribution 3: ICESat/IceBridge/ICESat-2 Emulator

Satellite measured
freeboard



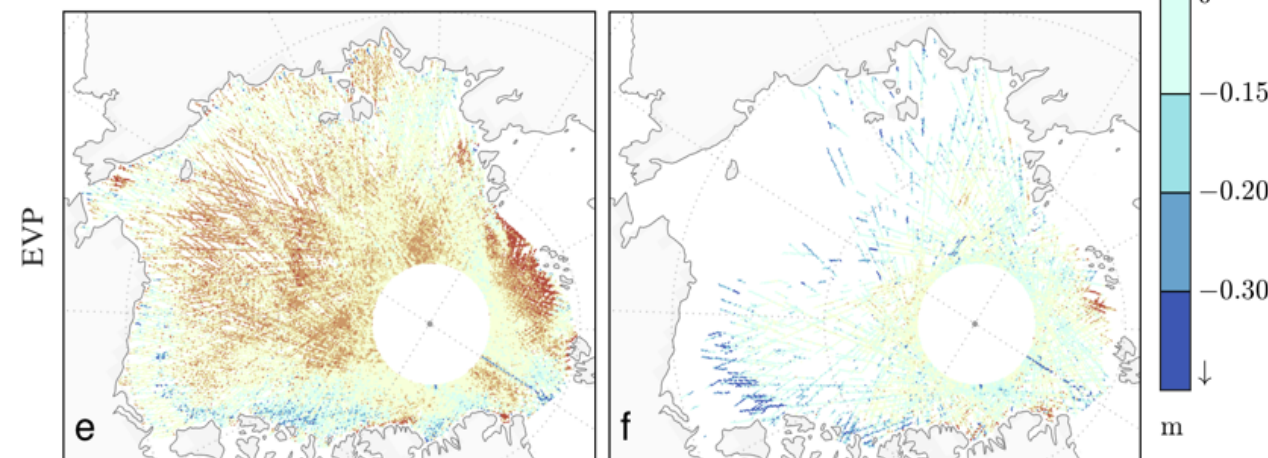
RASM
Anisotropic Sea Ice
Mechanics (EAP)



Model difference from
observations

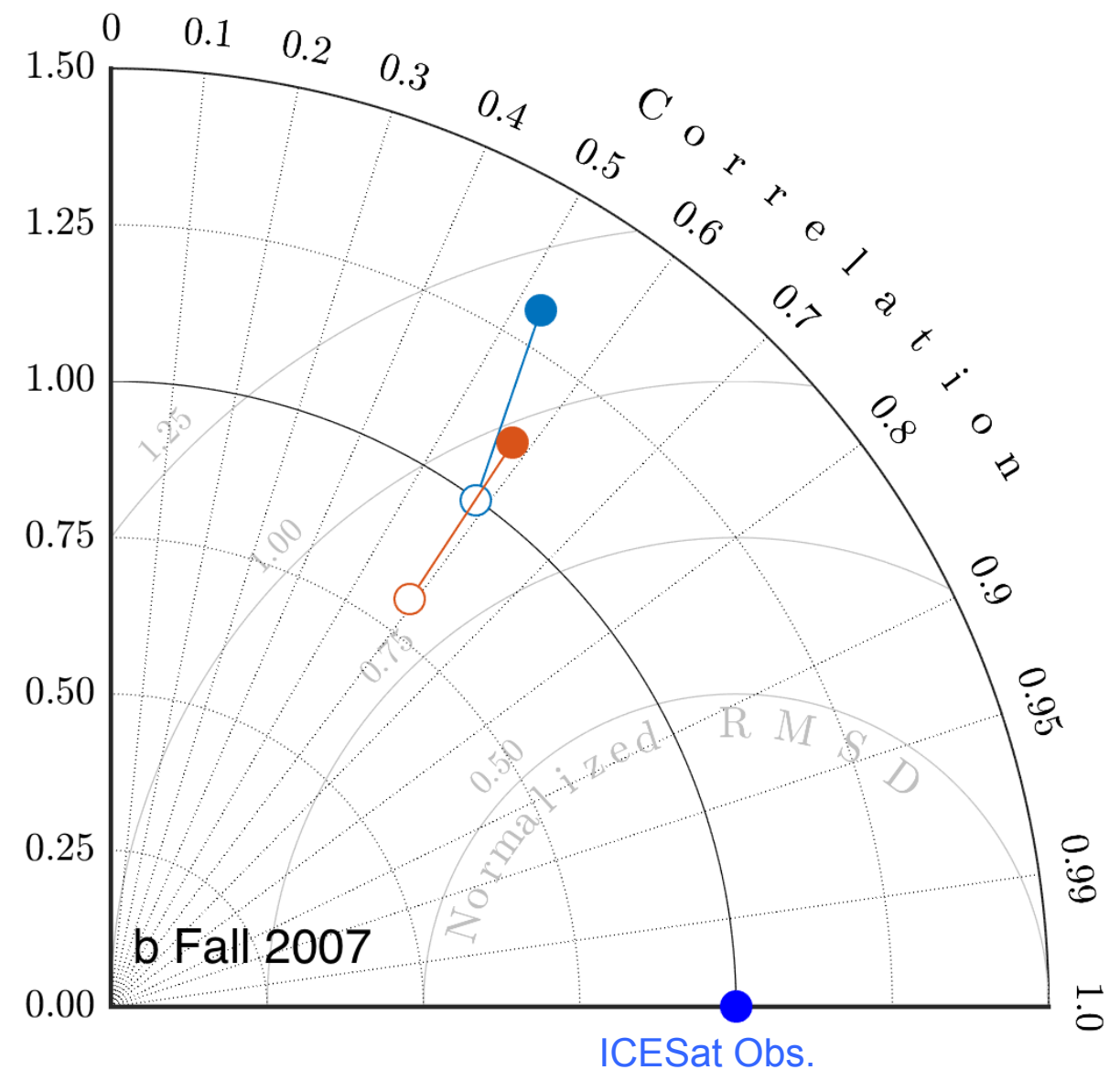
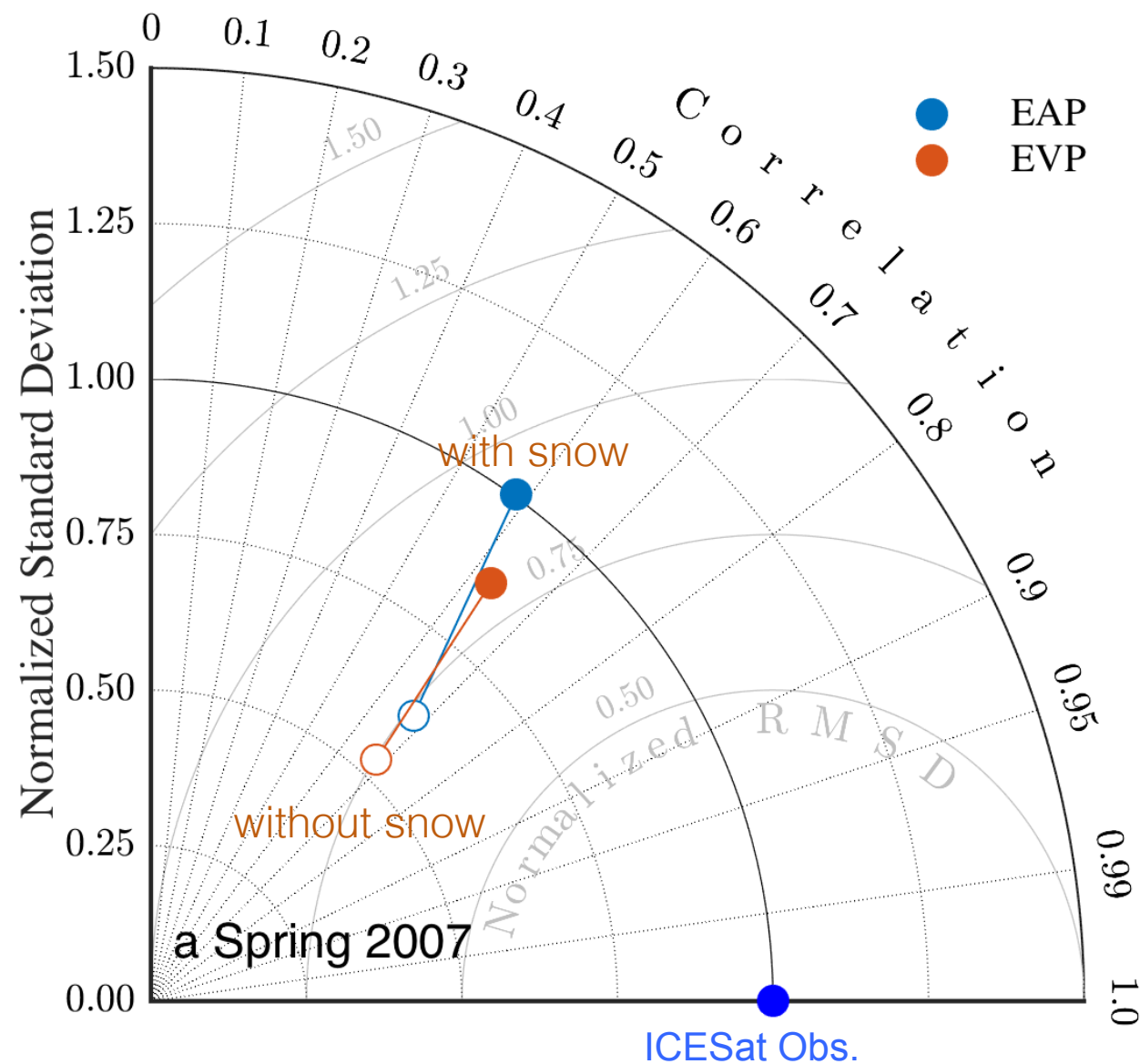
$$Bias(\overline{fb}_{\vec{model}}) = \langle \overline{fb}_{\vec{model}} \rangle - \langle \overline{fb}_{\vec{obs}} \rangle$$

RASM
Isotropic Sea Ice
Mechanics (EVP)



Example of bias calculation of RASM freeboard with ICESat freeboard

Contribution 3: ICESat/IceBridge/ICESat-2 Emulator



Track-wise freeboard evaluation, ICESat lasers 3H and 3I

NPS estimated level of participation: 0.25 FTE

CICE Consortium Oversight, coordination and tasks

